Here's some sound construction advice for tackling the most important aspect of an earth-set dwelling

By Martin S. Harris, Jr.

American industry has tried, with great success, to convince consumers that they should buy its products or services rather than create them for themselves. Law and medicine have gone to the greatest lengths to create and preserve their respective monopolies, using both propaganda and licensing rules to retain control, but the construction industry is also guilty of this behavior.

The public has resisted, fighting back with alternatives to the traditional disciplines and displaying a near bottomless appetite for the technical information—presented in a non-technical format—whereby they can make their own choices and further their own self-reliance.

Poor construction advice

In construction, the alternative track record has been less than perfect: a lot of do-it-yourself construction advice which has been published has not been particularly attentive to the basic engineering requirements which any builder, amateur or professional, must respect. In areas ranging from joist and rafter sizing to foundations, from insulation to ventilation, I've seen and read a lot of advice which would entice the do-it-yourself builder into inadequate construction practice.

Given the popularity of earth-set construction in the owner- builder sector (for reasons ranging from environment and esthetics to energy efficiency and maintenance) it's not surprising that foundation design stands high on the list of -areas where inadequate consideration is being given by the self-help book-writers to the engineering aspects of their advice.

In probably the worst example, a well-known back-to-the-earth magazine published a piece suggesting that a 10-foot-high retaining -wall for the backside of an earth-set house could be built of conventional single thickness 12-inch concrete block construction.

For something like that to work—for the construction to stand up against earth, moisture, and frost pressure—would require more than the lightest of backfill soils, the best of drainage, the least of frost; it would also require a lot of luck. Such luck does prevail, sometimes, and construction far weaker than conventional engineering requires sometimes does work; but sometimes is not often enough for construction. There must be a near- perfect expectation that the wall will work every time, not just most of the time.

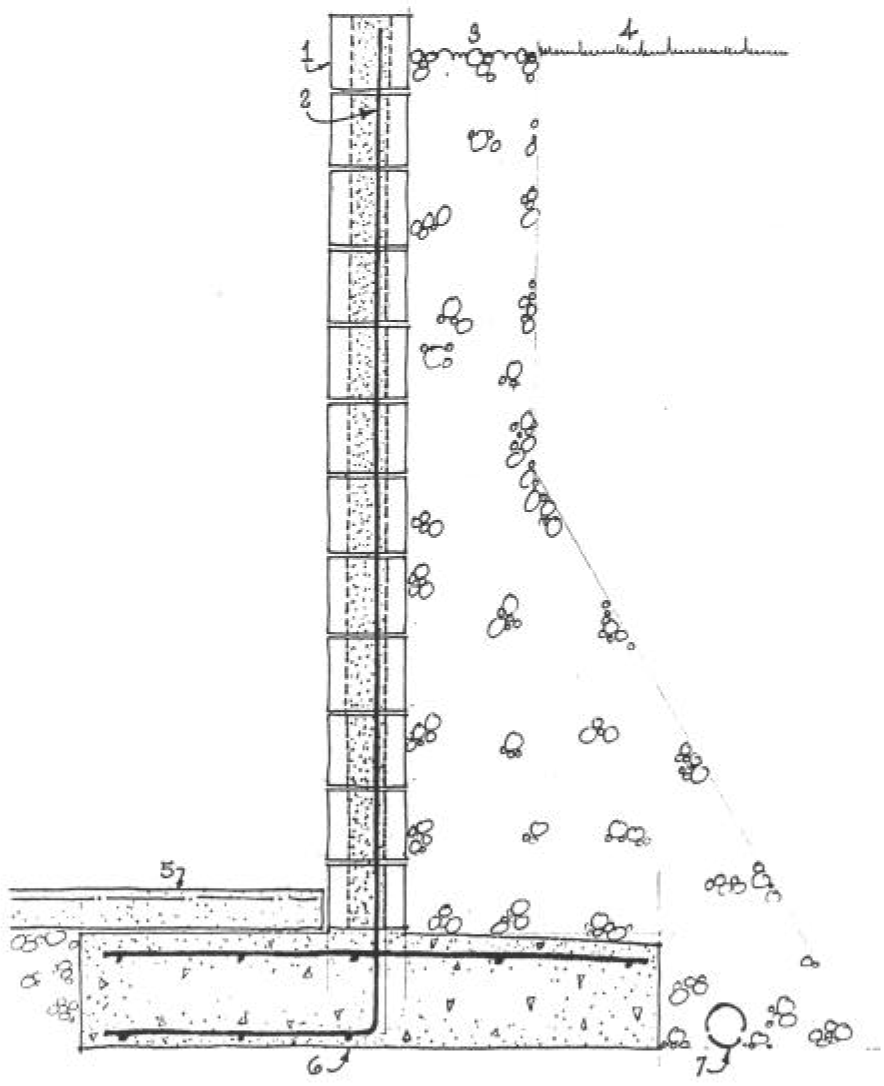
The case for strict by-the-book construction is weakened, unfortunately, by the fact that very substantial safety factors are built into conventional engineering practices; and so one can disregard these standards to a limited extent and the work will still stand. Surely everyone has seen unreinforced 8-inch concrete block foundation walls

8 feet high which have not failed, even though such walls are deemed inadequate by most engineering calculations and most building codes.

In fact, such walls will work most of the time, given three conditions: light, easily draining sandy and gravelly backfill soils; limited frost action; and a building design wherein the tops of the foundation walls are braced against each other by the first floor framing.

Contrarily, such walls are almost guaranteed not to work for very long where soils are heavy clays and silts and therefore poorly draining; where climatic conditions result in significant frost penetration below ground surface; and where the building design is of the walk-out basement configuration, so that the deck framing can't help brace the foundation.

Of the three, the last is most obvious. Clearly, most earth-set housing (except the relatively unpopular sunken-center-courtyard design) falls in this category, and so proper foundation work is particularly important to owner-builders of earth-set housing.



This cross-section of an 8-foot reinforced concrete block foundation wall shows the wall itself (1), its cores filled solid with concrete, and a #3 re-bar (2), continuous vertically in each core; the well-draining granular backfill (3), and the native soil beyond (4), the interior floor slab (5), the poured footing, which should be somewhat more than half the height of the wall and a foot thick (6), and the perforated footing drain (7), which picks up ground moisture and leads it away from the founcation. Note how the top of the footing is sloped to help drainage.

Know the soil type

Soil types are frequently less obvious. In dry summer weather (which is when most excavation and construction take place) even the poorest of soils can look pretty good, almost granular in appearance. It's only when they're water-saturated that they display their tendencies to swell up (clays), slump and flow (clays and silts) and retain moisture, the last characteristic particularly damaging if the trapped water freezes and creates pressures strong enough to damage a1l but the heaviest structures.

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If backfill soils aren't fast-draining sands and gravels, the best (and long-term lowest-cost) practice is to replace at least the first two feet behind- the foundation walls with coarse gravels which will drain properly.

Drainage is vital

It's also good practice to install perforated drainage pipe, in a bed of fast draining gravel, behind every foundation wall, so that water simply can't build up and freeze in place or even leak inside the building. Such piping should slope slightly as it leads off to daylight somewhere downslope of the building.

If you do such basic drainage work properly, there's a good chance you can dispense with the labor and

expense of some elaborate waterproofing treatment for the backside of the foundation wall.

Most usual "waterproofing" of the black tar paint-on variety isn't waterproofing at all, but merely "dampproofing" (read the label's fine print) and won't stand up against heavy doses of trapped ground water. True "waterproofing," on the other hand, of either the paint-on or applied membrane varieties, is far more expensive and isn't really necessary where proper drainage has been installed.

There's one kind of applied membrane which has a cellular structure to provide drainage while waterproofing the foundation wall, supposedly enabling the builder to backfill with poor materials. It hasn't been available long enough to build an industry reputation, although the advertising is impressive.

All the above drainage design work is fairly independent of the design of the actual foundation wall itself: there's a fairly limited choice of wall materials and design, and just about all of them depend on good drainage as just described.

There's stone, the traditional material, and concrete block, the modern substitute. There's cast-inplace concrete, where the builder sets up forms and pours the wall in place; and there's pre-cast concrete which is brought from the yard in pieces and assembled with a crane on site.

There are even wood foundations: the old heavy-timber palisade design and the modern lightly framed wood design, the latter not recommended for walk-out basement configurations.

The masonry and concrete types have long been available with steel rod reinforcing, which reduces the mass of material needed; now there's plastic mesh reinforcing as well, placed not in the wall but in the backfill behind it to prevent earth movement and a buildup of soil pressure behind the wall.

Let's look at each of these.

Stone and concrete block

Stone and concrete block, laid up with mortar but without any steel reinforcing, need to be about one-half in thickness at the base of the height of fill they are designed to retain. An 8-foot wall, for example, needs to be about 4 feet thick at the base to meet this rule of thumb.

For those uneasy about the masonry skills needed to lay up stone or block in mortar joints, the work can be laid up dry; concrete block, in particular, can be laid up dry, the cores filled solid with concrete, and the exposed face parged with a fiberglass-based mortar to produce a smooth surface.

Cast-in place concrete is almost always done with steel reinforcing bars placed in the forms prior to pouring, thus reducing the amount of concrete needed. To determine the specific dimensions of steel and concrete required, one can consult an engineer or refer to a standard design out of a manual like, for example, the Concrete Reinforcing Steel Institute (CRSI) manual.

Pre-cast concrete is usually similar in design to cast-in- place, but looks better because it's poured under shop conditions. It ends up with more joints than cast-in-place. There's also precast in large blocks or interlocking logs, usually employed for exterior retaining walls rather than building construction.

Wood foundations of the palisade design aren't used much any more because of the very large quantities of lumber needed, the difficulties of getting a smooth interior surface, the impermanence of the structure, and so on.

Wood foundations of the light framing design have been around for about 10 years; they require very careful attention to drainage and moisture barriers and are completely dependent on the floor framing above to hold them in place. Although advertised as permanent, they draw some skepticism from the public in this respect.

My choice

For the owner-builder I'd select **reinforced concrete-block masonry** as the wall system of choice.Here's why:

- **It requires no form construction**
- **All the work can be handled manually**
- **It need not be non-stop**
- **It's permanent**
- **It can provide a finished interior appearance**
- **It's very price-competitive.**

I'd use the dry-laid block, fill the cores with mortar as each course is laid, and use short lengths of steel

rebar overlapping in the core filling to create a continuous steel-reinforced design and avoid the use of enormous quantities of block.

And, of course, I'd be super careful with the drainage and backfill. It's not visible when the work is done but it's just as important as the exposed construction.

After the walls are up

The-retaining-wall foundation used for earth-set construction can be used in two basically different ways:

- **to support a basically traditional above-ground structure.**
- **to support a roof deck sufficiently rigid to carry an over-burden of soil, thereby creating an earth-sheltered structure buried except for the walk-out exposures.**

Clearly, the decision regarding choice-of-superstructure would be made much earlier in the design process, because a foundation intended to carry a roof deck with soil over- burden will require a few refinements not needed for more conventional work, but the principles remain the same. In fact, one can change the design decision at this late point in the work without creating overwhelming problems.

. My own preference is to go earth-set rather than earth-sheltered, with a more or less conventionally-framed above-Wound structure rather than the far-more-heavily structured wood or concrete deck needed to carry the soil over-burden.

That's because simplicity of construction, relatively low cost, high insulation values, and inexpensive above-ground cubage can be obtained via earth-set, whereas earth-sheltered is more complex in terms of structure, in terms of waterproofing, and is more limited in terms of expansion options. In fact, to go earth-set with a tradition. al above-ground structure is to go back to one of the basic design preferences of pre-Revolutionary southern New England, where Cape-type dwellings were frequently backed up against south facing hills so that there was no northern exposure at all.

As the photos on pages 55 and 57 show, such work done at the tail end of the 20th century can have all the esthetic and practical appeal of its historical ancestor with none of the problems or limitations the old-timers had to accept because they lacked concrete, steel, and waterproofing technologies.

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